

CUSTOMER NO. 46850

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Re: Attorney Docket No. 35-19

In re application of: Dennis S. Greywall and Bernard Yurke

Serial No.:	10/789,154	Group Art Unit:	1732
Filed:	02/27/2004	Examiner:	Lambelet, Lawrence Emile
Matter No.:	990.0611	Phone No.:	571-272-1713

For: Carbon Particle Fiber Assembly Technique

PRE-APPEAL BRIEF REQUEST FOR REVIEW

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicant requests review of the final rejection in the above-identified application. No amendments are being filed with this request. This request is being filed with a notice of appeal. The review is requested for the reasons stated in the following Remarks/Arguments section.

REMARKS/ARGUMENTS

Claims 1-31 are pending in the application. Claims 14 and 22-27 are withdrawn from consideration due to a restriction requirement. The Applicants hereby request further examination and reconsideration of the application in view of these remarks/arguments.

On page 2, the Examiner rejected claims 1-3, 10-12, and 15-20 under 35 U.S.C. § 103(a) as being unpatentable over Lobovsky in view of Yodh. On page 4, the Examiner rejected claims 4 and 6-8 under 35 U.S.C. § 103(a) as being unpatentable over Lobovsky in view of Yodh, and further in view of Smalley. On page 5, the Examiner rejected claims 5 and 9 under 35 U.S.C. § 103(a) as being unpatentable over Lobovsky in view of Yodh, and further in view of Islam. On page 6, the Examiner rejected claims 13 and 21 under 35 U.S.C. § 103(a) as being unpatentable over Lobovsky in view of Yodh, and further in view of Ko. On page 6, the Examiner rejected claims 28-31 under 35 U.S.C. § 103(a) as being unpatentable over Lobovsky in view of Yodh, and further in view of Smalley, Islam, and Ko. For the following reasons, the Applicants submit that all claims that are being examined on the merits are allowable over the cited references.

Claims 1-13, 15-21, and 28-31:

Claim 1 is directed to a method for assembling carbon particles into at least one fiber. The method has the steps of: (A) aligning said carbon particles by flowing a mixture of said carbon molecules and a curable liquid down a tapering tube starting at a first end of said tapering

tube; and (B) curing said flowing mixture at least near a second end of said tapering tube whereby a fiber is formed.

Lobovsky discloses a method for making carbon-nanotube structures, such as fibers, ribbons, and yarns. According to his method, carbon nanotubes are first dispersed in a solvent with the aid of a surfactant. A narrow jet of the resulting carbon-nanotube dispersion is then injected through a tapered nozzle into a rotating bath of a more viscous liquid in such a way that shear forces at the point of injection cause partial alignment and aggregation of the dispersed nanotube bundles. The rotating viscous liquid neutralizes the dispersing action of the surfactant, strips the solvent, and causes the aligned nanotubes to weave around each other, entangle, and coagulate into a filament. The wet filament is then washed in water, withdrawn from the wash bath, and dried. During the drying process, capillary forces collapse the loosely entangled carbon nanotubes of the filament into a compact, relatively dense fiber.

Yodh discloses methods for making (i) stable dispersions having a relatively high weight fraction of carbon nanotubes and (ii) solid composite materials containing carbon nanotubes. One method of making a solid composite material disclosed by Yodh includes dispersing carbon nanotubes and a surfactant in a hardenable matrix precursor and then hardening the precursor by exposure to light, heat, or radiation. Yodh does not teach or suggest making carbon nanotube fibers from his dispersions or solid composite materials.

In the rejection of claim 1, on page 3 of the office action, the Examiner admitted that “Lobovsky does not teach using a curable liquid near the end of the tapering tube” and “curing [the flowing mixture] at locations before and after the end.” However, the Examiner contended that one skilled in the art would be motivated to use Yodh’s dispersions having curable precursors in the method of Lobovsky and “would have found it obvious to locate the curing event near the end of the tube, instead of upstream where a solid mass formed too soon would clog the tube, or downstream where a free-flowing stream would break apart.”

For the following reasons, the Applicant submits that one skilled in the art would **not** be motivated to modify the method of Lobovsky as suggested by the Examiner and that the rejection of claim 1 over the combination of Lobovsky and Yodh is improper and should be withdrawn.

The purpose of the method of Lobovsky is to make dense fibers consisting essentially of carbon nanotubes. It is therefore essential for Lobovsky to be able to strip the solvent in which the carbon nanotubes are initially dispersed. It is also essential that the carbon nanotubes can move with respect to each other after they have been injected into the rotating bath so that they can interweave, entangle, and coagulate. The modification that the Examiner is suggesting in the rejection of claim 1 is to substitute the strippable solvent of Lobovsky by the hardenable matrix precursor of Yodh and then actually harden the precursor near the end of the nozzle as the carbon-nanotube dispersion is being injected into the rotating bath.

First of all, after the precursor hardens, it can no longer be stripped by the rotating viscous liquid of the rotating bath. Consequently, the resulting fiber will no longer consist essentially of carbon nanotubes, as required by Lobovsky, but rather it will consist of carbon nanotubes and the hardened matrix.

Second, the hardened precursor will freeze the motion of carbon nanotubes with respect to each other. Because the carbon nanotubes do not move in the hardened matrix, they can no longer interweave, entangle, and coagulate, as required by Lobovsky.

It is therefore clear that the proposed modification completely **destroys** the functionality of the method of Lobovsky, i.e., the ability to make dense fibers consisting essentially of carbon

nanotubes. One skilled in the art would certainly **not** be motivated to make a modification that makes the method unusable, the Examiner's statement to the contrary notwithstanding.

On page 9 of the office action, in the section entitled "Response to Arguments", the Examiner further states that "the motivation [to combine Lobovsky and Yodh] would have been the simplification of the process of assembling a carbon nanotube fiber achieved by eliminating downstream steps through process change." The Applicant submits that this statement is simply **not** true. What remains for Lobovsky to do after the injection of the mixture into the rotating bath is to wash and dry the carbon-nanotube filament to obtain the end product. After the modification suggested by the Examiner, to obtain the same product, Lobovsky would have to somehow remove the hardened matrix and then bind the remaining (previously embedded in the matrix) carbon nanotubes together.

First of all, the Applicant submits that one skilled in the art would not judge the substitution of the steps of washing and drying the filament by the steps of removing the hardened matrix and binding the remaining carbon nanotubes together to be a simplification, the Examiner's statement to the contrary notwithstanding. Indeed, the Examiner's statement is akin to saying that extracting metal-reinforcement bars or wires from a wall made of reinforced concrete is easier than doing laundry. It is therefore submitted that the motivation suggested by the Examiner is unrealistic and improper.

Next, the prior art, including the whole disclosures of Lobovsky and Yodh, do not even suggest that the hardened matrix can somehow be removed and the recovered carbon nanotubes can be bound together to form a dense carbon-nanotube fiber, let alone actually disclosing, even in principle, how such removal and binding can be accomplished. To enable one skilled in the art to perform these steps the Examiner would have to use the disclosure of Applicants' own specification. However, such usage would constitute hindsight and, as such, is not permissible under patent law.

For all these reasons, the Applicants submit that the Examiner improperly combined the teachings of Lobovsky and Yodh to reject claim 1. It is therefore submitted that claim 1 is allowable over Lobovsky and Yodh. For similar reasons, the Applicants submit that claims 19 and 28 are also allowable over the respective combinations having Lobovsky and Yodh. Since the rest of the claims depend variously from claims 1, 19, and 28, it is further submitted that those claims are also allowable over the respective combinations having Lobovsky and Yodh.

Claims 4 and 28:

Claim 4, which depends from claim 1, further recites the step of heating the fiber so as to cause at least some volatile elements therein to substantially dissipate therefrom. Claim 28 recites a similar step.

On page 4 of the office action, in the rejection of claim 4, the Examiner admitted that Lobovsky and Yodh "do not teach heating the fiber ... to drive off volatiles." However, the Examiner then contended that Smalley "does teach heating carbon nanotube mixtures to remove carbon contaminants in the Abstract." The Examiner did not contend that the teachings of Islam and Ko could rectify the deficiencies of Lobovsky and Yodh with respect to claim 4.

The following is the exact quotation from Smalley's abstract: "The method includes the steps of **heating the mixture** under oxidizing conditions sufficient to remove the amorphous carbon, followed by recovering a product comprising at least about 80% by weight of single-wall carbon nanotubes." [Emphasis added.] Further description of the "heating the mixture" step can be found, e.g., in Smalley's paragraphs [0015] and [0096] through [0098]. More specifically, Smalley's paragraph [0098] explains:

The purification process of the present invention comprises heating the **SWNT-containing felt** under oxidizing conditions to remove the amorphous carbon deposits and other contaminating materials. In a preferred mode of this purification procedure, the felt **is heated in an aqueous solution** of an inorganic oxidant, such as nitric acid, a mixture of hydrogen peroxide and sulfuric acid, or potassium permanganate. Preferably, SWNT-containing felts are refluxed in an aqueous solution of an oxidizing acid at a concentration high enough **to etch away amorphous carbon** deposits within a practical time frame, but not so high that the single-wall carbon nanotube material will be etched to a significant degree. [Emphasis added.]

For the following reasons, the Applicant submits that the heating step of Smalley is very different from the first heating step of claim 4.

It is clear from the above-cited description that Smalley is using a heated aqueous solution of an inorganic oxidant to oxidatively dissolve and substantially wash away amorphous carbon. Thus, at least the following four differences between the method of Smalley and the heating step of claim 4 are readily apparent: (1) the method of Smalley uses a heated **aqueous solution of an inorganic oxidant**, while the heating step of claim 4 recites **neither an aqueous solution nor an oxidant**; (2) the method of Smalley **oxidatively dissolves** in the heated aqueous solution, while the heating step of claim 4 substantially **vaporizes**, as the term “volatile” implies (according to the Webster’s Ninth New Collegiate Dictionary, 1987: Merriam-Webster, Springfield, MA, p. 1321, volatile means readily vaporizable at a relatively low temperature); (3) the method of Smalley removes **amorphous carbon**, while the heating step of claim 4 removes **elements of the solidified curable liquid**; and (4) amorphous carbon is **not** a **volatile** element, whereas the heating step of claim 4 removes **volatile** elements. The Applicants submit that all these differences render the use Smalley in the rejection of claim 4 improper.

For all these reasons, the Applicants submit that the Examiner mischaracterized the teachings of Smalley and used them improperly to reject claim 4. For similar reasons, the Applicants submit that the Examiner improperly used the teachings of Smalley to reject claim 28. It is therefore submitted that the rejections of claims 4 and 28 over the respective combinations having Smalley should be withdrawn. These facts provide additional reasons for the allowability of claims 4 and 28 over the cited references.

In view of the above arguments and remarks, the Applicant believes that all claims that are being examined on the merits are in condition for allowance. Therefore, the Applicant believes that the entire application is now in condition for allowance, and early and favorable action is respectfully solicited.

Respectfully submitted,

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